Physics Project

Investigate and compare how the rates of powdered or granulated solids through a funnel are affected by (a) the size of the solid particles and (b) any one of the funnel dimensions.

Background - Solid matter (like sand) is made up of many individual small particles is called a granular material, and the individual particles are called grains. Granular materials can range in size from very small powders like sugar and flour that you use in your kitchen, to very large objects like rocks.

SALT

RICE

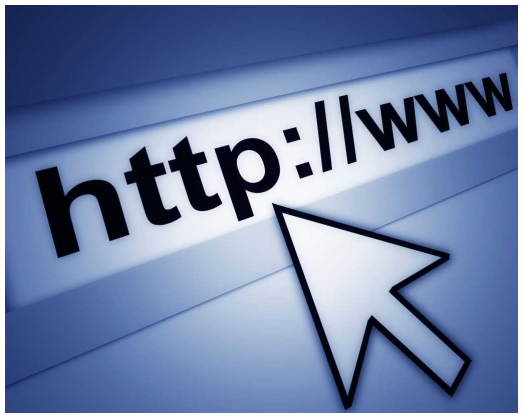
SKITTLES

Part 1 (Introduction)

(i) Statement or problem to be investigated - What you are going to do **in your own words**

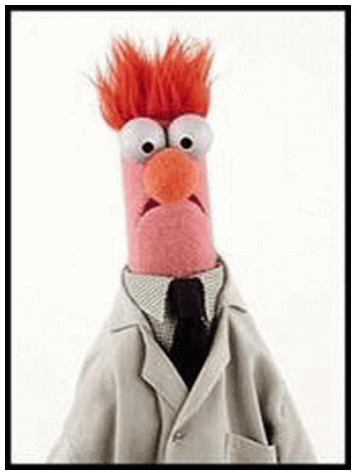
(ii) Background research undertaken - You will have to look up a few websites and books to find information for your investigation.
You may even have to ask your teacher or someone at home for information.
This is your background research you will need to give **at least 3 pieces** of background research. Make sure for all three you mention where you got the piece of information and what you used it for.

Internet (Give full link!)



Books (Author and Publisher Page and Details)

Teacher



More Background...

In some factories, granular solids are stored in a **hopper**. At the bottom of the hopper there is a **funnel**. Engineers need to know the **Mass Flow Rate.** This is a measure of how much material leaves the funnel *per unit time.*

It can be measured in grams per second (g/s).

http://www.sciencebuddies.org/science-fair-projects/project_ideas/Phys_p091.shtml#summary

Mass Flow Rate = Mass/Time

We have to use 2 funnels.
We can use glass ones or make our own from plastic bottles.
2 litre bottles may be best.

Part 2 (Preparation and Planning)

(i) Variables

1. The **Independent** Variable (what I will change - **Grain size**)
2. The **Dependent** Variable (what I will measure - **Flow Rate (Mass/Time)**)
3. **Controls** (what I will keep the same -
   - **mass of substance being tested (salt, rice, skittles)**
   - **same funnel for testing all 3 substances**
   - **same procedure for timing the flow**

(ii) Equipment: List every piece of equipment you use, leave nothing out!

e.g. Safety glasses, retort stand, 2 funnels (plastic bottles), 3 beakers, electronic balance, stopwatch, ruler (for measuring bottle opening), notebook and pencil.

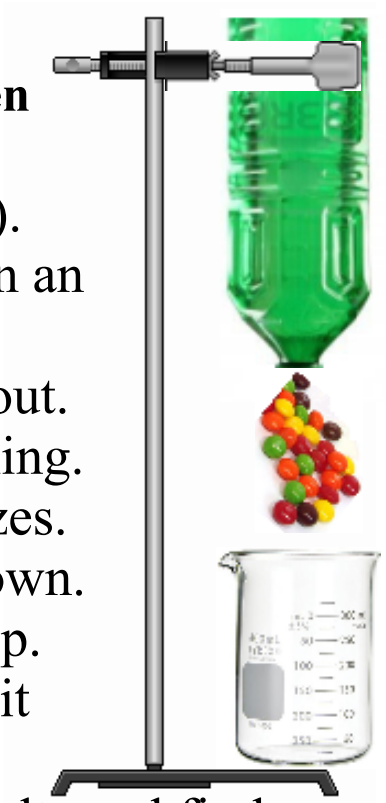
(iii) Tasks: This is the list of jobs that need to be done in order.

e.g. Using a ruler measure the size of the grains of each substance.
Carefully weigh the same amount of all the substances, e.g. 150g
Fill the funnel with Substance 1 and hold a hand on the bottom of funnel. Release the grains and note time when grains stop.
Repeat for other 2 substance and make table/plot graph of results.
Repeat the whole experiment with another funnel of different proportions.

Part 3 (Procedures, apparatus etc.)

(i) Safety - Safety goggles to stop salt getting in eyes.
Take care cutting the plastic bottles as they can be sharp.
Check glassware for cracks.

(ii + iii) Procedure with diagram - Write it like a recipe.
If people cannot copy the experiment using your steps then you need to do them again.



Take the 3 substances to be used (Salt, Rice and Skittles).
Into 3 different beakers measure exactly 100 g of each on an electronic balance using a spatula if necessary.
Get 2 identical 2litre plastic bottles and cut the bottoms out.
Take one bottle and cut the top off to make a wider opening.
Measure the width of both bottle openings and record sizes.
Choose one of the bottles and set up the apparatus as shown.
Block bottom of funnel and pour the 100 g of salt into top.
Remove the hand and start the stopwatch. Note the time it takes to empty the funnel completely.
Repeat 3 times for each substance being tested. Note results and find average for each substance with this funnel.
Repeat steps with other funnel and compare the results of both funnels.

(iv) Data and observations - Decide what results you are going to take and when you are going to take them before starting the test.
e.g. Start stopwatch when hand is removed and stop stopwatch when last grains fall from the funnel into the beaker.

Make a data table before you start your experiment so you can record your measurements as soon as you observe them. This will ensure that you are consistent in the way that you record your results and it will also make it easier to analyse. Make sure to give your tables and graphs a name or number.
e.g.

Table No. 1 - Narrow Funnel Opening (24 mm)

	Salt (0.2 mm)	Rice (7 mm)	Skittles (13 mm)
Time 1			
Time 2			
Time 3			
Average			

(iv) Data and observations - Decide what results you are going to take and when you are going to take them before starting the test.
e.g. Start stopwatch when hand is removed and stop stopwatch when last grains fall from the funnel into the beaker.

Make a data table before you start your experiment so you can record your measurements as soon as you observe them. This will ensure that you are consistent in the way that you record your results and it will also make it easier to analyse. Make sure to give your tables and graphs a name or number.
e.g.

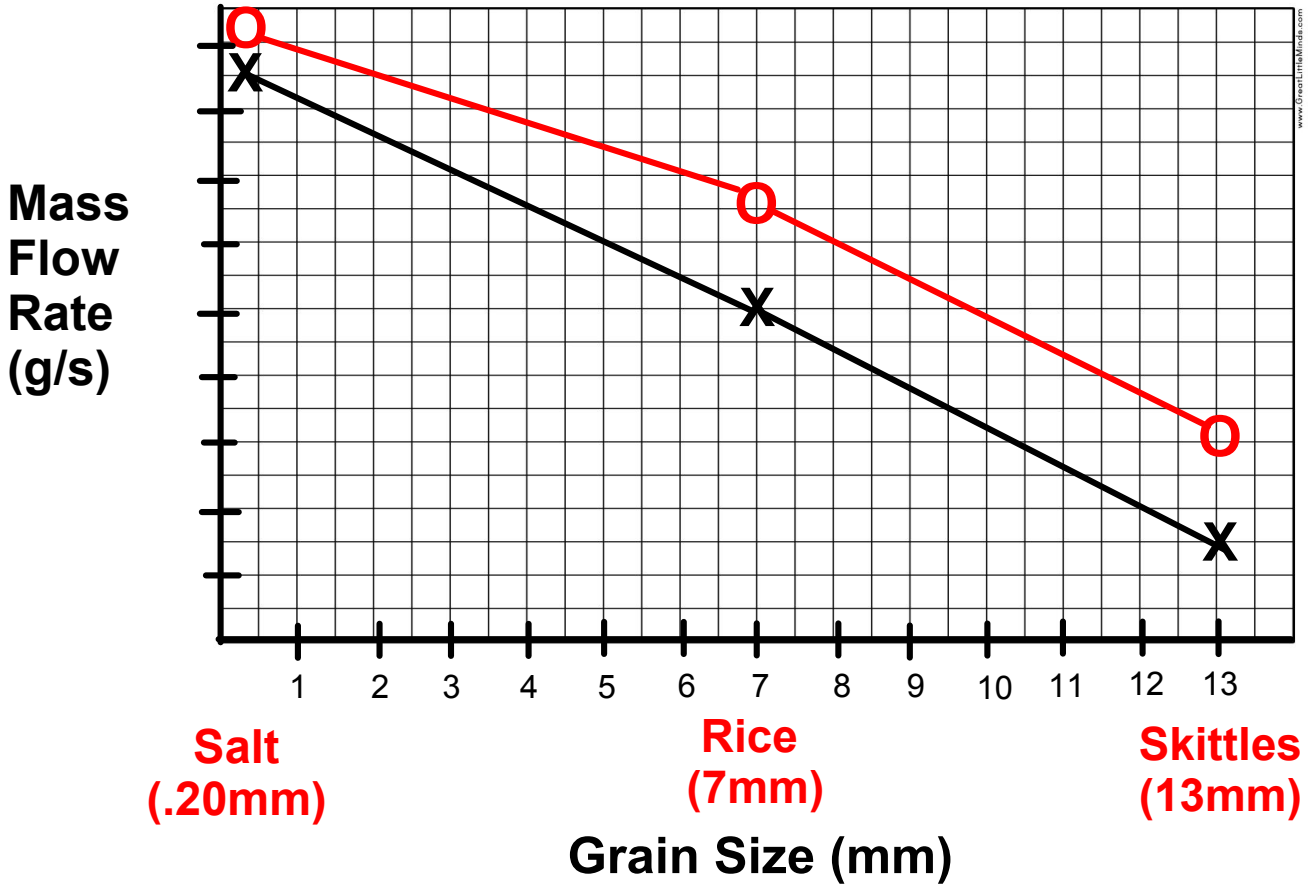
Table No. 2 - Wide Funnel Opening (35 mm)

	Salt (0.2mm)	Rice (7mm)	Skittles (13mm)
Time 1			
Time 2			
Time 3			
Average			

X = Narrow Funnel (24mm)

O = Wide Funnel (35 mm)

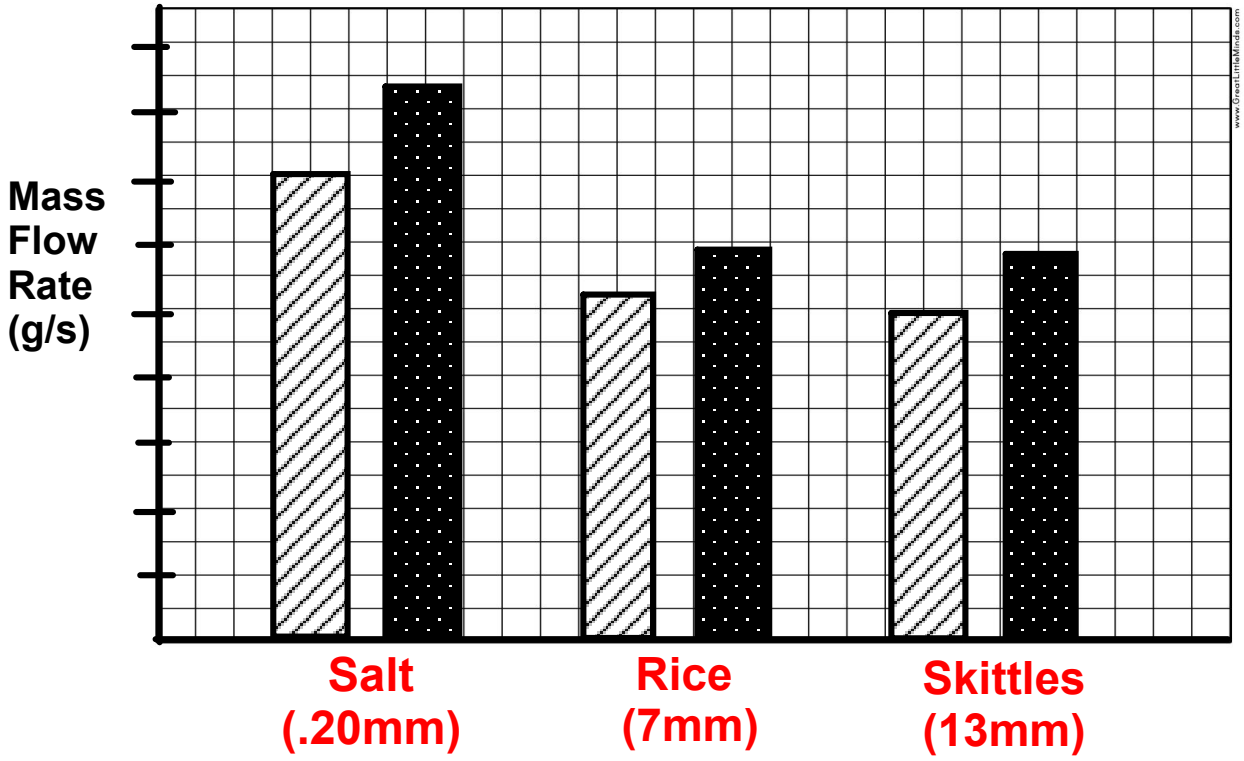
Graph No. 1 - Mass Flow Rate vs Grain Size.



= Narrow Funnel (24mm)

= Wide Funnel (35mm)

Graph No. 2 - Mass Flow Rate vs Substance.



Now, analyze your data, and see if you can figure out a correlation between the size of the materials and their mass flow rate.

What appears to flow faster, small materials or large materials?

Can you explain your results?

Hint: Think about how small grains can *pack* together in the hopper compared to much larger grains (in other words, the *density* of the grains as a group, including air spaces), and how smaller grains roll through the funnel compared to larger grains.

Do you think other characteristics of the materials, such as their shape, may have also affected how fast they flowed?

Perhaps? Biggest difference will be in skittles as the size of them in narrow opening is limiting to mass flow rate?

Part 4 (Analysis)

(i) Calculations and Data Analysis -

Make sure you outline any calculations (e.g. finding averages)
To find the Mass Flow Rate we have to divide 100 g by the time for each test and then find the average flow rate for each substance to plot on graph.

(ii) Conclusion and Evaluation of result

Some useful sentence starters in this section are:
· I can see from my results that ……..
· When I changed ……..., …….. changed by……..
· From the graph I can see that …….

Answer some of the following questions in your written report.
· Do your results answer the question you were asking at the start?
· Were the results what you were expecting?
· Is there a trend in your results or did anything unusual happen?
· If you got an unusual result why do you think this happened?
· If you drew a graph did you get a straight line or a curve – what does this show?

Part 5 (Comments)

(i) Refinements, extensions and sources of error

· Do your results answer the what you were trying to find out
· Were you surprised by these results?
· Was there anything that might have affected your results.
Blocked funnel due to grain size? Should be ignored and test repeated.
· Are there any changes you would make if you did the experiment again?
Use larger amounts for more accurate results.
· Is there any way of making it more accurate - do more repetitions
· Does your investigation have any real life applications.
Any factory with a hopper and funnels can be more efficient knowing the mass flow rate of its products.
· Could you develop your experiment further, how?
Use more of substance and use 5 substances.
Use another funnel with a different diameter?